11-17 527 Rec'd PCT/PTO 16 NOV 2000

FORM PTO-1390 (REV 11-98) US DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371		ATTORNEY'S DOCKET NUMBER 001394 U.S. APPLICATION NO. (If known, see 37 CFR 1 5) 09/700649
INTERNATIONAL APPLICATION NO. PCT/GB99/01379	INTERNATIONAL FILING DATE 5/18/1999	PRIORITY DATE CLAIMED 5/18/1998
TITLE OF INVENTION Microelectrode System		
APPLICANT(S) FOR DO/EO/US Freeman, et al		

NOV 16 2000

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This express request to begin national examination procedures (35 U.S.C. 371 (f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 37 (b) and PCT Articles 22 and 39(1).
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c)(2))
   a. ☒ is transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ has been transmitted by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☐ A translation of the International Application into English (35 U.S.C. 371 (c)(2)).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C.371(c)(3)).
   a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ have been transmitted by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☒ have not been made and will not be made.
8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)). (unsigned)
10. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern document(s) or information included:

11. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A FIRST preliminary amendment.
    ☐ A SECOND or SUBSEQUENT preliminary amendment.
14. ☐ A substitute specification.
15. ☒ A change of power of attorney and/or address letter. (Combined with declaration)
16. ☒ Other items or information: Return Postcard and copy of PCT as published.

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U.S. APPLICATION NO (if known, see 37 CFR 1.5) 09/700649	INTERNATIONAL APPLICATION NO PCT/GB99/01379	ATTORNEY'S DOCKET NUMBER 001394

17. [X] The following fees are submitted:

	CALCULATIONS	PTO USE ONLY
BASIC NATIONAL FEE (37 CFR 1.492 (a)(1) - (5)) : Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO. $970.00		
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO $840.00		
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO $760.00		
International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4) $670.00		
International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) $96.00		
ENTER APPROPRIATE BASIC FEE AMOUNT =	$840.00	
Surcharge of **$130.00** for furnishing the oath or declaration later than [ ] 20 [X] 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).	$130.00	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	23 - 20 =	3	X **$18.00**	$54.00	
Independent claims	1 - 3 =	0	X **$78.00**	$0.00	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ **$260.00**	$0.00	
TOTAL OF ABOVE CALCULATIONS =				$1,024.00	
Reduction of ½ for filing by small entity, if applicable, A Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28).				$512.00	
SUBTOTAL =				$512.00	
Processing fee of **$130.00** for furnishing the English translation later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492 (f)).				$0.00	
TOTAL NATIONAL FEE =				$512.00	
Fee for recording the enclosed assignment (37 CFR 1.21 (h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property +				$0.00	
TOTAL FEES ENCLOSED =				$512.00	
				Amount to be: refunded	$
				charged	$

a. [X] A check in the amount of $ 512.00 o cover the above fees is enclosed.

b. [ ] Please charge my Deposit Account No. 50-0545 in the amount of $________ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. [X] The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 50-0545. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:
FACTOR & PARTNERS, LLC
100 W. Monroe Street, Suite 300
Chicago, IL 60603
(312) 578-0400
(312) 578-8220

SIGNATURE:

Jovan N. Jovanovic
NAME

40039
REGISTRATION NUMBER

09/700649

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IN THE
UNITED STATES
PATENT AND TRADEMARK OFFICE

IN RE APPLICATION OF:	Freeman	
CASE:	001394	PRELIMINARY AMENDMENT
SERIAL NO.:	To be assigned	
FILED ON:	November 15, 2000	
FOR:	Microelectrode System	

ASSISTANT COMMISSIONER
FOR PATENTS
Washington DC 20231

ATTENTION OF:

EXAMINER:

Dear Sir:

If any charges or fees must be paid in connection with the following communication, they may be paid out of our Deposit Account No. 50-0545.

Please enter the foregoing amendment **PRIOR TO CALCULATION OF FILING FEES**..

FACTOR & PARTNERS, LLC
100 West Monroe Street, Suite 300
Chicago, IL 60603
(312) 578-0400

Jody L. Factor 34157
Jovan N. Jovanovic 40039
William L. King, III 46830

IN THE CLAIMS CANCEL

Please cancel claims 24-28, without prejudice.

IN THE CLAIMS AMEND

Claim 3, line 1	Delete "or 2".
Claim 4, line 1	Delete "any preceding claim" and insert -- claim 1 --.
Claim 5, line 1	Delete "any preceding claim" and insert -- claim 1 --.
Claim 6, line 1	Delete "any of claims 1 to 4" and insert -- claim 1 --.
Claim 7, line 1	Delete "any preceding claim" and insert -- claim 1 --.
Claim 8, line 1	Delete "any preceding claim" and insert -- claim 1 --.
Claim 9, line 1	Delete "any preceding claim" and insert -- claim 1 --.
Claim 10, line 1	Delete "any preceding claim" and insert -- claim 1 --.
Claim 11, line 1	Delete "any preceding claim" and insert -- claim 1 --.
Claim 13, line 1	Delete "or 12".
Claim 14, line 1	Delete "any preceding claim" and insert -- claim 1 --.
Claim 15, line 1	Delete "any preceding claim" and insert -- claim 1 --.
Claim 16, line 1	Delete "any preceding claim" and insert -- claim 1 --.
Claim 18, line 1	Delete "any preceding claim" and insert -- claim 1 --.
Claim 20, line 1	Delete "any preceding claim" and insert -- claim 1 --.

Claim 21, line 1	Delete "any preceding claim" and insert – – claim 1 – –.
Claim 23, line 1	Delete "any preceding claim" and insert – – claim 1 – –.

REMARKS

AFTER entry of the foregoing amendment, the application is in condition for calculation of filing fees and substantive examination on the merits.

Should anything further be required, a telephone call to the undersigned, at (312) 578-0400, is respectfully invited.

Respectfully submitted,

FACTOR & PARTNERS, LLC

Dated: November 16, 2000

Jovan N. Jovanovic
One of Attorneys for Applicant

5/PRTS

09/700649

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WO 99/60392

PCT/GB99/01379

Microelectrode system

The present invention relates to an electrode system, and particularly to a microelectrode system suitable for use in preparative and analytical chemistry.

Microelectrode systems are used extensively in research and are so named because their dimensions are on the micrometre scale. Such microelectrode systems provide very high field gradients and diffusion characteristics due to their small size. In addition, these types of microelectrode systems have found some limited commercial utility in biomedical applications and are typically used in, for example, blood gas analysis.

Reliable operation of microelectrode systems for preparative electrochemistry and electroanalytical techniques depends critically upon their geometry and the reproducibility of their manufacture. The performance of such a system generally improves as the dimensions of the system are reduced which is why microelectrode and even nanometre scale microelectrode systems are often desirable.

A disadvantage of known microelectrode systems of this type is that the reproducibility and reliability of the fabrication process and the geometries which may be adopted become more limited as the scale is reduced.

The present invention seeks to provide an improved microelectrode system which is more straightforwardly and reproducibly manufactured irrespective of dimensionality.

Thus viewed from one aspect the present invention provides a microelectrode system comprising a laminated structure having at least one conducting layer capable of acting as an electrode, at least one dielectric layer, an aperture formed in the laminated structure, and contact means for allowing electrical contact with at least one conducting layer.

As the dimensions of the microelectrode system of the invention are extremely small, the fields generated within the laminated structure are exceptional and enable highly efficient measurement and/or modification of materials entering into or passing through the system. The laminated structure is simple to manufacture to extremely high tolerances. In addition, the structure has extremely low dead volume thereby considerably simplifying physical sampling regimes.

The aperture may be in the form of a hole which extends through the laminated structure and is open at both ends. Alternatively, the aperture may be in the form of a well having an open end and an opposite end being closed to form a well bottom. In both embodiments, the internal wall of the hole or well formed in the microelectrode system may be uniform (*eg* substantially tubular) or non-uniform to provide non-uniform fields if desired. Materials may be passed into or through the laminated structure (via the aperture) where *inter alia* synthesis, analysis or sequencing as desired takes place.

The microelectrode system of the invention may comprise a plurality of apertures (*eg* holes or wells) formed within the laminated structure and spaced apart from one another. Each hole or well may be individually addressable, in which case each hole or well may have a different function. Alternatively, groups of holes or wells (or the totality of the holes or wells) in a structure may be addressed in parallel thereby enabling amplification of signals and parallel material processing. This latter system may be suitable for larger scale synthetic applications.

In one embodiment, the microelectrode system comprises at least one pair of substantially collinear wells having a common closed end. Particularly preferably, the microelectrode system comprises a plurality of such pairs.

At least one conducting layer of the microelectrode system of the invention acts as an electrode on the internal wall of the hole or well. The or each electrode may be treated

to provide appropriate functionality (*eg* pH measurement or surface treatment for electro-catalysis) by known chemical and/or electrochemical and/or physical modification techniques.

The laminated structure may comprise a plurality of conducting and a plurality of dielectric layers. Preferably consecutive conducting layers are separated by dielectric layers. Particularly preferably, a dielectric layer is uppermost in the laminated structure. In one embodiment, the laminated structure preferably comprises three conducting layers. Electrical fields are generated between the layers forming the laminated structure and within the aperture to provide the desired conditions.

Typically, the electrodes are formed from a noble metal, preferably gold. Gold may be sputtered onto a polymer which is capable of acting both as the mechanical support and as the dielectric layer. Any form of polymer or other dielectric material which is capable of acting as a support may be used such as for example polyethylenetetraphthalate (PET). Other specialised materials such as ion exchange polymers (*eg* cation doped polystyrene sulphonate) may be used for specialised applications.

Advantageously, the or each dielectric layer is made from a rubbery material. A suitable material is a polymer which swells when molecules of (for example) water enter the solid state matrix. During use of the microelectrode system, the rubbery dielectric layers separating pairs of conducting layers swell thereby changing the inter-electrode distance. Thus, the interspaced electrodes may be interrogated to determine the degree of swelling of the dielectric layers as a function of the measured resistance.

In more complex systems, material may be grown between the or each conducting layer and the or each rubbery dielectric layer, and the stress placed on the material as a consequence of the swelling of the or each dielectric layer may be measured.

A reagent loaded or functionalised dielectric layer may be used to provide additional functionality by providing ions or other materials to ensure the reproducible behaviour of subsequent systems within the structure. Ions may be conveniently provided by ion exchange resin materials. Other matrices could be employed to provide co-factors for biosensors, etc.

A specialised dielectric layer may also be used. The specialised layer may be in the form of an ion exchange resin, gel or solid electrolyte. In such a system, mass transport from one lateral region of the structure to another may be effected by *inter alia* osmosis, electro-osmosis, electrophoresis, electrochromatography or ion migration. Reverse flow and counter current techniques may be employed to effect changes in process flows including *inter alia* deionisation.

The laminated structure may be built on silicon. This has the advantage of being optically flat. Alternatively, the laminated structure may be built on a polymeric material (*eg* a polymeric material comprising one or more polymers).

The layers forming the laminated structure may be laid down using any one of a number of known techniques including casting, spinning, sputtering or vapour deposition methods. The aperture may be mechanically or chemically introduced into the laminated structure. Advantageously, a micron gauge wire made of (for example) silver may be introduced into the laminated structure which wire may be etched out once the laminar structure has been completed. Alternatively, lithographic techniques or physical techniques such as laser oblation and neutron annihilation may be used. It is possible to produce highly uniform electrode layers with precise separations using such techniques allowing highly reproducible functional structures to be achieved.

The microelectrode system of the invention has many applications. For example, it may be used in the deionisation

of a solution positioned on one side of a membrane forming the closed end of a well. In such a case, ions may be pumped through the microelectrode system as a consequence of a potential difference applied to electrodes on either side of the common well bottom. In such a case, the well bottom may be conveniently formed from an ion exchange material. The microelectrode may also be used in preparative electrochemistry, electroanalysis and chromatography or other separation techniques. It may also be used as a sensor.

Where the aperture is in the form of a through hole, the microelectrode system according to the present invention may be used in preparative electrochemistry. In such a case, the reactants on one side of the electrode structure are passed through the hole using (for example) a pressure gradient. As they pass through the holes, the reactants are modified by the applied electric field within each hole, either producing the product directly or generating intermediates which undergo further reaction to form the desired product.

If, for example, the microelectrode system was required to have biological functionality for use in an enzyme or antibody system, the electrodes may be formed from metal treated with an organic conducting layer to prevent the activity of the biological agent from being destroyed.

A silver conducting layer may be used which itself may be chloridised to form a silver/silver chloride reference electrode if desired.

The dimensions of the layers and hole or well forming the microelectrode system may be tailored as desired. The precise dimensions of the microelectrode system depend upon the materials used and the techniques employed to form the microelectrode system.

The diameter of the hole or well is typically in the range 0.5 to 500 microns, preferably 1 to 200 microns, particularly preferably 2 to 10 microns, especially preferably about 5 microns.

The thickness of the or each dielectric layer may be in the range 0.5 to 10000 microns, preferably 0.5 to 1000 microns, particularly preferably 1 to 1000 microns, especially preferably 1 to 60 microns, more especially preferably 1 to 10 microns. Where the dielectric is uppermost or intermediate in the laminated structure, the thickness is typically about 5 microns. Where the dielectric is on the base of the laminated structure, the thickness is typically about 55 microns.

The thickness of the or each conducting layer may be in the range 0.5 to 500 microns, preferably 1 to 100 microns, particularly preferably 1 to 10 microns, especially preferably about 3 microns.

At a location remote from the hole or well is provided a means to enable electrical contact with the or each of the conducting layers. One such means of providing electrical contact would be to slice back the outer edges of the dielectric layers thereby exposing the extreme ends of each of the conducting layers. These exposed ends allow electrical contact to be made.

When a microelectrode system according to the present invention is used in a mass transport system, the potential difference created causes diffusion of desired chemical species to the hole or well. In some cases (for whatever reason) this process is slow and the mass transport may be aided through use of *inter alia* a piezo-electric vibrator or an ultrasonic probe. Mass transport may be additionally controlled (where required) by conventional macroscopic means used in electrochemistry. These techniques include membrane and diffusion, wall jet/wall pipe techniques, rotation, vibration, etc. In the case of a microelectrode system having a through hole, the mass flow may additionally be controlled using differential pressure techniques.

The microelectrode system according to the invention may be in the form a substantially one-dimensional array (*eg* a tape) or a multi-dimensional array (*eg* a sheet or more complex

matrix) to enable repeated measurements with single use systems.

Preferably, the microelectrode system of the invention further comprises a microheater structure incorporated into the system to control local conditions. Preferably, the microheater is in the form of a resistive element laid down using known semi-conductor techniques. The resistive element may provide localised heating.

The invention will now be further described by way of example only with reference to the accompanying drawings in which:

Figure 1a is a schematic representation of an microelectrode system according to the invention incorporating a well;

Figure 1b is a schematic representation of an microelectrode system according to the invention incorporating a through hole;

Figure 2a is a schematic representation of an microelectrode system according to the invention having three electrodes and incorporating a well;

Figure 2b is a schematic representation of an microelectrode system according to the invention having three electrodes and incorporating a through hole;

Figure 3 is a schematic three-dimensional representation of an microelectrode system according to the present invention incorporating two electrodes and a through hole;

Figure 4a is a schematic representation of an microelectrode system according to the invention incorporating two electrodes, a reagent-loaded or functionalised dielectric and a well;

Figure 4b is a schematic representation of an microelectrode system according to the invention incorporating two electrodes, a reagent loaded or functionalised dielectric, and a through hole;

Figures 5a (side elevation) and 5b (plan) are schematic representations of an microelectrode system according to the invention incorporating a specialised or functionalised layer structure;

Figure 6 is a schematic representation of a microelectrode system according to the invention forming a membrane transport system;

Figure 7 is a schematic representation of a microelectrode system according to the invention forming an impedance imaging system; and

Figures 8a and 8b illustrate preferred embodiments of microelectrodes of the invention.

Referring to Figure 1a, a microelectrode system 1 comprises alternating layers of conductor 3 and dielectric (or insulator) 4. The laminated structure 2 comprises two conductor layers 3 and two dielectric layers 4 formed on a base 5 of silicon or a polymeric material. The conducting layers 3 form electrodes in the microelectrode system 1. The laminated structure has formed within it an aperture in the form of a well 6 being open at one end 7 and closed at the opposite end 8.

The microelectrode system 10 shown in Figure 1b has formed within the laminated structure 2 a through hole 11 and comprises three dielectric layers 4 and two conducting layers 3.

Figures 2a and 2b illustrate microelectrode systems 20 and 30 respectively which are similar to the microelectrode systems 1, 10 with similar reference numerals retained to avoid confusion. Each of the microelectrode systems 20, 30 comprises three conducting (electrode) layers 3 and three dielectric layers 4. Hole 11 (Figure 2b) or well 7 (Figure 2a) define an internal wall formed from alternating layers of insulating and conducting material. This produces a circular micro-band microelectrode system in the form of a uniform tube. This can be seen more clearly with reference to Figure 3 which is a

three-dimensional representation of the microelectrode system 10 of Figure 1b.

Materials passing into the structure may be pre-treated. A system suitable for pretreatment of material is shown in Figures 4a and 4b (where parts equivalent to those in Figures 1a and 1b have been given equivalent reference numerals). The microelectrode systems 50, 60 contain two electrode layers 3, two dielectric layers 4 and a reagent loaded or functionalised dielectric layer 5. The reagent loaded or functionalised dielectric layer 5 is able to provide additional functionality by providing ions or other materials to ensure the reproducible behaviour of subsequent systems within the structure. Ions could be provided by ion exchange resin materials. Other matrices could be employed to provide co-factors for biosensors, etc. The layer 5 could act as a buffer if, for example, there was some kind of ion exchange taking place where a remote reservoir was replenishing the ions exchanged within the medium in contact with the membrane.

Referring now to Figure 5a and 5b, a microelectrode system according to the invention is designated generally by the reference numeral 70 with parts equivalent to those shown in Figure 1b given equivalent reference numerals. The microelectrode system 70 comprises a specialised layer 13 between two electrode layers 3. The system further comprises means 14 to produce physical or chemical gradients or potentials to the specialised layer 13. The specialised layer 13 may be in the form of an ion exchange resin, gel or solid electrolyte. In such a system 70 mass transport from one lateral region of the structure to another may be effected by, for example, osmosis, electro-osmosis, electrophoresis, electrochromatography, ion migration, etc. Reverse flow and counter current techniques may be employed to effect changes in process flows including *inter alia* deionisation.

In Figure 6, a microelectrode system 80 suitable for use in deionisation of a solution is designated generally by the

reference numeral 80. The microelectrode system 80 comprises a plurality of wells 82. Each of the wells 82 is split into pairs by the presence of a continuous layer 84 which serves as a common well bottom for each pair. The well bottom is formed from an ion exchange material. Electrodes on either side of the well-bottom generate a potential gradient which forces ions to move across the membrane. This system may be used to deionise water.

Figure 7 illustrates a microelectrode system suitable for impedance imaging (*eg* mammography). It comprises alternating conducting 3 and dielectric layers 4 with a gold overplating 71 which is contactable with the skin for example. It is not important in this embodiment for the overplating material to contact in the centre of the hole. The overplating adopts a shape according to local variations in the environment. Provided the plating extends beyond the hole or well to the upper surface thereby allowing electrical contact to be made with an external surface, the shape and size is not critical. The overplating may be applied by standard electroplating methods (electrochemical methods).

Figures 8a and 8b illustrate embodiments of the invention of the hole-type and well-type respectively. Dielectric layers are made from poly(ethylenetetraphthalate) and conducting layers from gold. The detailed construction of each embodiment is given in the following tables (typical ranges are given for illustrative purposes only):

1) Hole Structure (Figure 8a)

Dimensions (in microns):

Description	Letter	Dimension	Typical Range
Aperture	A	5	0.5 - 500

Description	Letter	Dimension	Typical Range
First dielectric layer	B	5	1 - 1000
First conducting layer	C	3	0.5 - 500
Second dielectric layer	D	5	0.5 - 1000
Second conducting layer	E	3	0.5 - 500
Third dielectric layer	F	5	1 - 1000

2) Well structure (Figure 8b)

Dimensions (in microns):

Description	Letter	Dimension	Typical Range
Aperture	A	5	0.5 - 500
First Dielectric layer	B	5	1 - 1000
First conducting layer	C	3	0.5 - 500
Second dielectric layer	D	5	0.5 - 1000
Second conducting layer	E	3	0.5 - 500
Third dielectric layer	F	55	1 - 10000

CLAIMS:

1. A microelectrode system comprising a laminated structure having at least one conducting layer capable of acting as an electrode, at least one dielectric layer, an aperture formed in the laminated structure, and contact means for allowing electrical contact with at least one conducting layer.

2. A microelectrode system as claimed in claim 1 wherein said aperture defines a uniform or non-uniform internal wall in the laminate structure.

3. A microelectrode system as claimed in claim 1 or 2 wherein said aperture defines a substantially tubular internal wall in the laminate structure.

4. A microelectrode system as claimed in any preceding claim comprising a plurality of apertures.

5. A microelectrode system as claimed in any preceding claim wherein said aperture is a through hole which extends through the laminated structure and is open at both ends.

6. A microelectrode system as claimed in any of claims 1 to 4 wherein the aperture is in the form of a well having an open end and an opposite end being closed to form a well bottom.

7. A microelectrode system as claimed in any preceding claim wherein at least one conducting layer is functionalised.

8. A microelectrode system as claimed in any preceding claim wherein at least one dielectric layer is made from a

rubbery material having a solid state matrix capable of swelling in the presence of a liquid or gas.

9. A microelectrode system as claimed in any preceding claim wherein consecutive conducting layers are separated by dielectric layers.

10. A microelectrode system as claimed in any preceding claim wherein the laminate structure is constructed on a base comprising silicon or a polymeric material.

11. A microelectrode system as claimed in any preceding claim comprising at least one pair of substantially collinear wells having a common well bottom.

12. A microelectrode system as claimed in claim 11 comprising a plurality of pairs of substantially collinear wells having a common well bottom.

13. A microelectrode system as claimed in claim 11 or 12 wherein said well bottom is formed from an ion exchange material.

14. A microelectrode system as claimed in any preceding claim wherein at least one conducting layer is metallic and treated with an organic conducting layer.

15. A microelectrode system as claimed in any preceding claim wherein at least one conducting layer is a silver/silver chloride reference electrode.

16. A microelectrode system as claimed in any preceding claim wherein at least one conducting layer consists essentially of gold.

17. A microelectrode system as claimed in claim 16, wherein at least one dielectric layer is polymeric and acts as a support for the gold conducting layer.

18. A microelectrode system as claimed in any preceding claim comprising means for assisting mass transport.

19. A microelectrode system as claimed in claim 18 wherein said means for assisting mass transport is a piezoelectric vibrator or ultrasonic probe.

20. A microelectrode system as claimed in any preceding claim comprising alternating conducting and dielectric layers.

21. A microelectrode system as claimed in any preceding claim wherein at least one dielectric layer comprises a specialised layer in the form of an ion exchange resin, gel or solid electrolyte.

22. A microelectrode system as claimed in claim 21 wherein the specialised layer is provided with means to apply physical or chemical gradients or potentials thereto.

23. A microelectrode system as claimed in any preceding claim wherein at least one dielectric layer comprises a reagent loaded or functionalised layer.

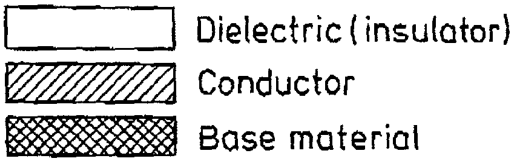
24. Use of a microelectrode system as claimed in any preceding claim for deionisation of a material.

25. Use of a microelectrode system as claimed in any of claims 1 to 23 for use in preparative electrochemistry.

26. Use of a microelectrode system as claimed in any of claims 1 to 23 for use in electroanalysis.

27. Use of a microelectrode system as claimed in any of claims 1 to 23 for use as a sensor.

28. Use of a microelectrode system as claimed in any of claims 1 to 23 for use in chromatography or separation techniques.



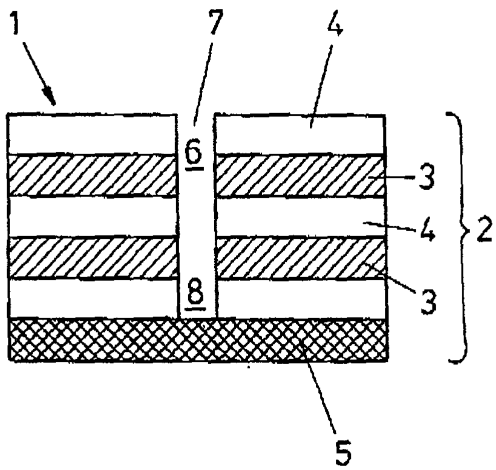


FIG. 1a

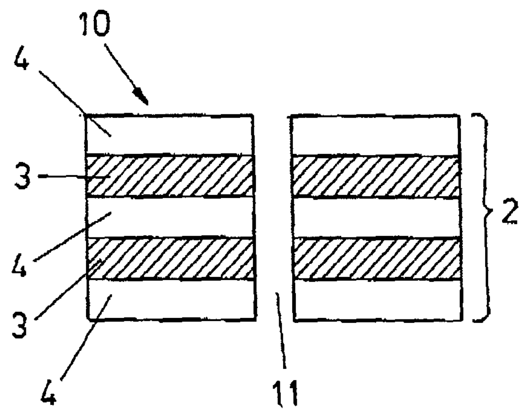
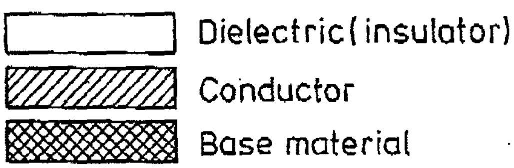


FIG. 1b



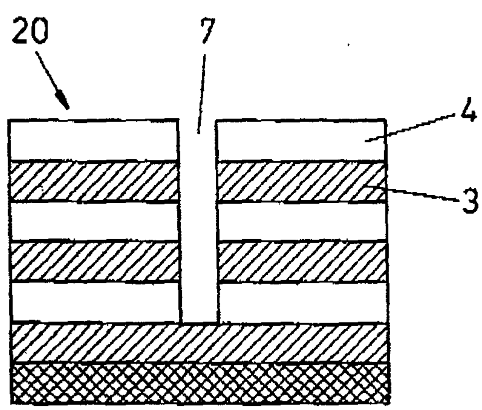


FIG. 2a

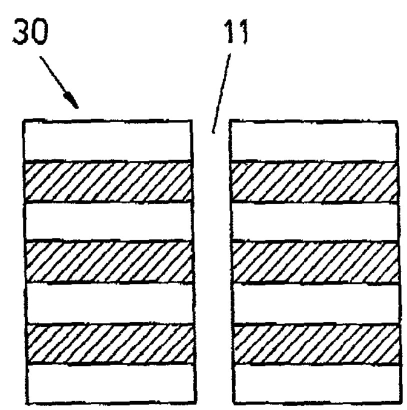


FIG. 2b

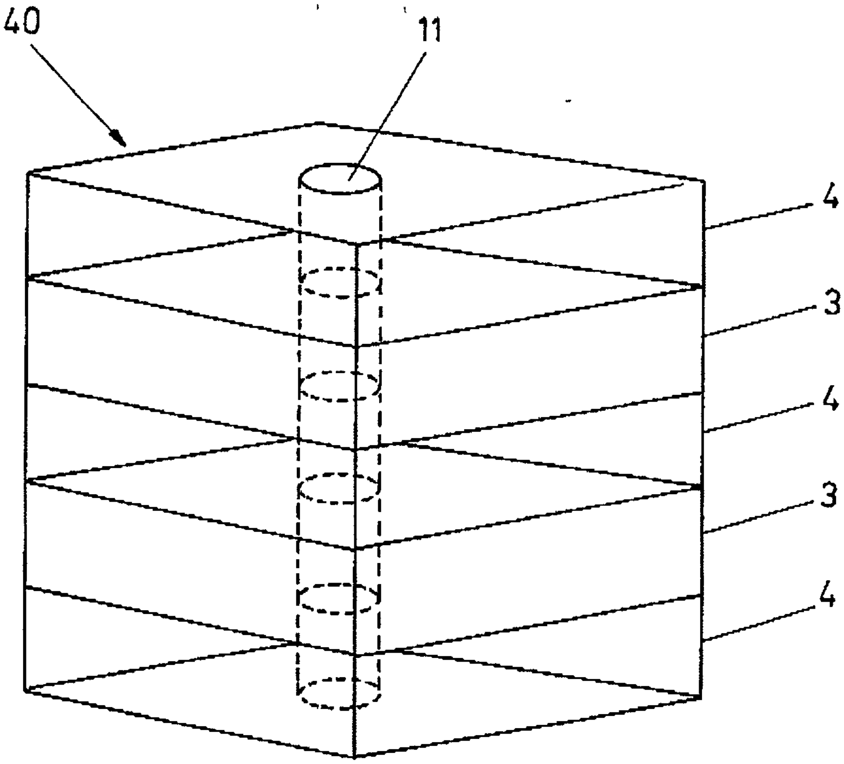
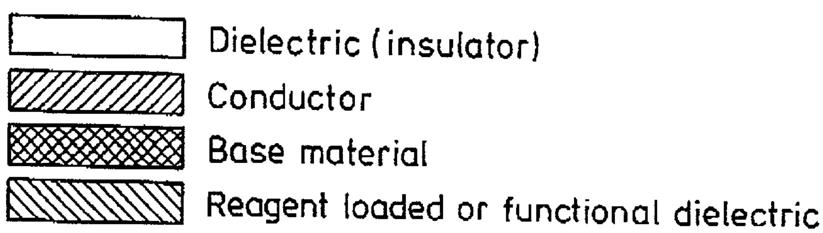


FIG. 3



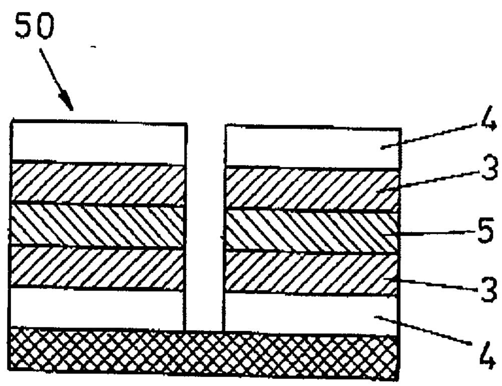


FIG. 4a

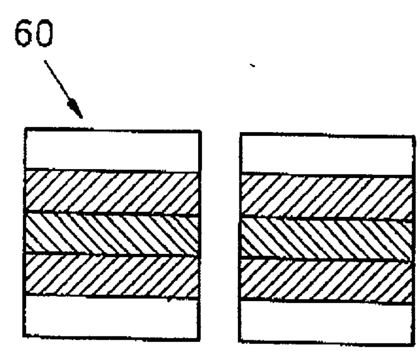


FIG. 4b

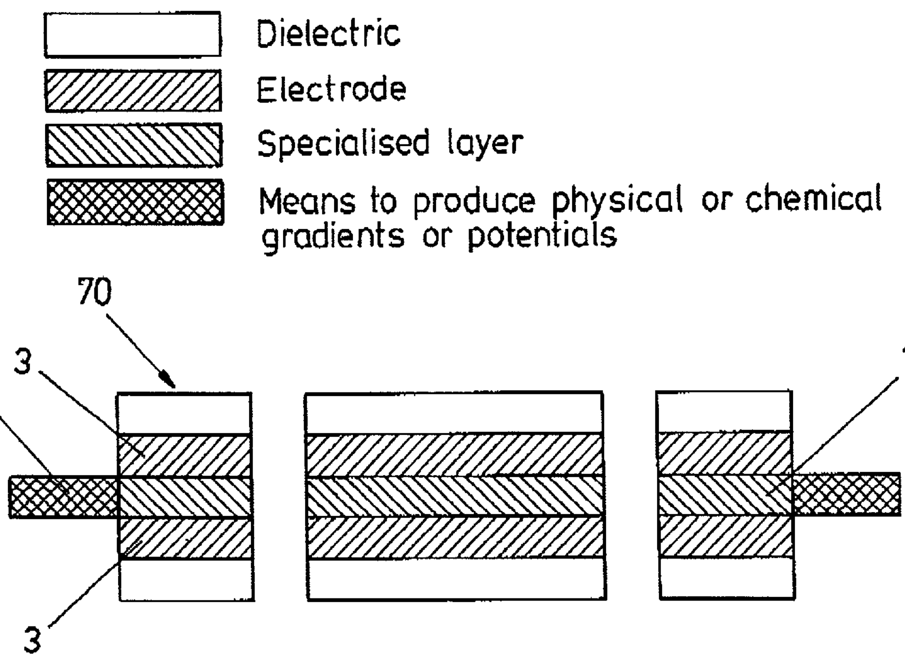

Dielectric
Electrode
Specialised layer
Means to produce physical or chemical gradients or potentials
70
14
3
3
13

FIG. 5a

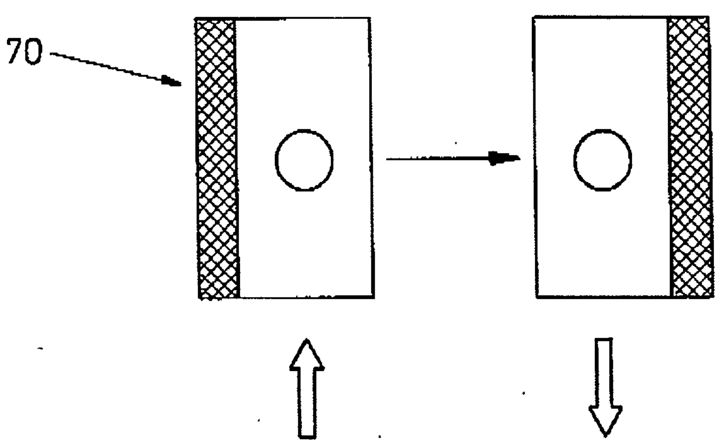

70

FIG. 5b

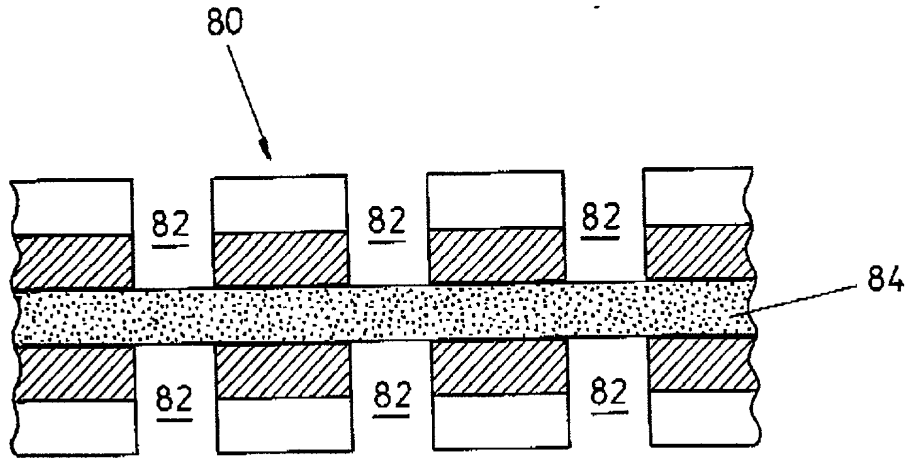


FIG. 6

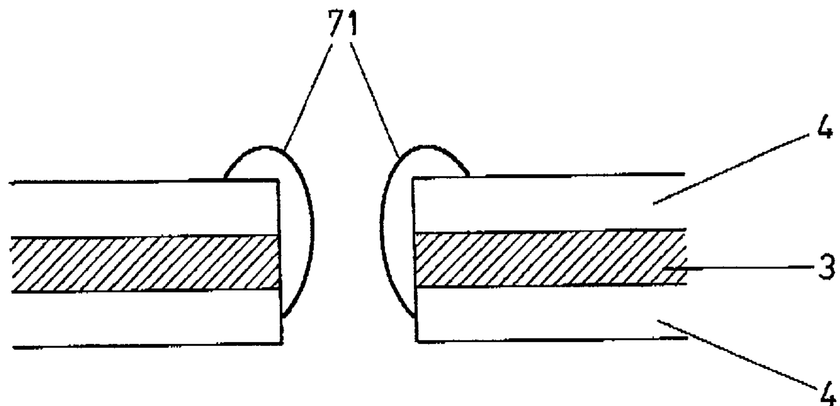


FIG. 7

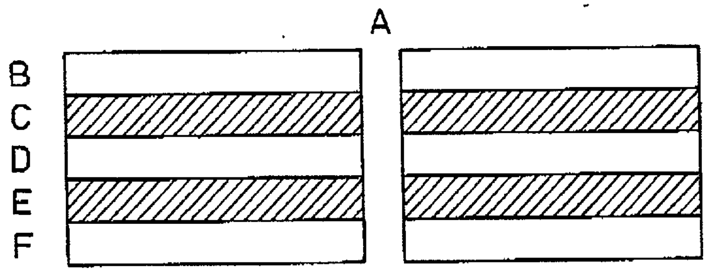


FIG. 8a

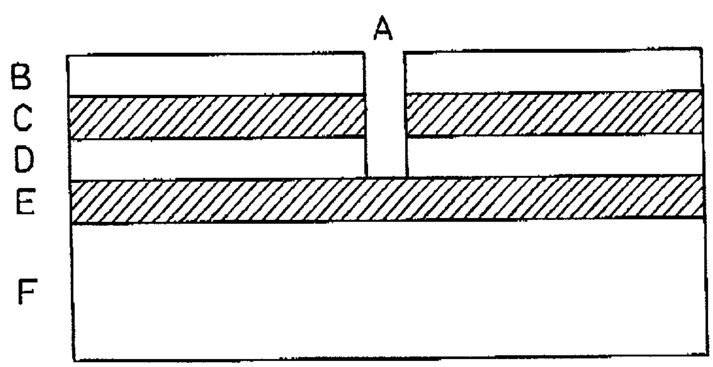


FIG. 8b

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Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Please type a plus sign (+) inside this box → ☐

DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION (37 CFR 1.63)

☐ Declaration Submitted with Initial Filing OR ☐ Declaration Submitted after Initial Filing (surcharge (37 CFR 1.16 (e)) required)

Attorney Docket Number	001394
First Named Inventor	Freeman et al.
COMPLETE IF KNOWN	
Application Number	09/700,649
Filing Date	11/6/2000
Group Art Unit	
Examiner Name	

As a below named inventor, I hereby declare that:

My residence, post office address, and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

MICROELECTRODE SYSTEM

(Title of the invention)

the specification of which

☐ is attached hereto
OR
☒ was filed on (MM/DD/YYYY) 11/6/2000 as United States Application Number or PCT International Application Number 09/700,649 and was amended (MM/DD/YYYY) ______ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56.

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or of any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Not Claimed	Certified Copy Attached? YES	NO
PCT/GB99/01379	PCT	05/18/99	☐	☐	☐

☐ Additional foreign application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto:

I hereby claim the benefit under 35 U.S.C. 119(e) of any United States provisional application(s) listed below.

Application Number(s)	Filing Date (MM/DD/YYYY)	
		☐ Additional provisional application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto.

Burden Hour Statement: This form is estimated to take 0.4 hours to complete. Time will vary depending upon the needs of the individual case. Any comments on the amount of time you are required to complete this form should be sent to the Chief Information Officer, Patent and Trademark Office, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Assistant Commissioner for Patents, Washington, DC 20231.

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DECLARATION — Utility or Design Patent Application

I hereby claim the benefit under 35 U.S.C. 120 of any United States application(s), or 365(c) of any PCT international application designating the United States of America, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT international application in the manner provided by the first paragraph of 35 U.S.C. 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

U.S. Parent Application or PCT Parent Number	Parent Filing Date (MM/DD/YYYY)	Parent Patent Number (if applicable)

☐ Additional U.S. or PCT international application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto.

As a named inventor, I hereby appoint the following registered practitioner(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith: ☒ Customer Number 22876 →
OR
☐ Registered practitioner(s) name/registration number listed below

22876
PATENT TRADEMARK OFFICE

Name	Registration Number	Name	Registration Number
Jody L. Factor Jovan N. Jovanovic William L. King	34157 40039 46830		

☐ Additional registered practitioner(s) named on supplemental Registered Practitioner Information sheet PTO/SB/02C attached hereto.

Direct all correspondence to: ☒ Customer Number or Bar Code Label OR ☐ Correspondence address below

Name	Jody L. Factor				
Address	100 West Monroe St., Suite 300				
Address					
City	Chicago	State	IL	ZIP	60603
Country	USA	Telephone	312-578-0400	Fax	312-578-8220

22876
PATENT TRADEMARK OFFICE

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Name of Sole or First Inventor: ☐ A petition has been filed for this unsigned inventor

Given Name (first and middle [if any])	Family Name or Surname
Neville John	Freeman

Inventor's Signature						Date	2001/03/01
Residence: City	Tarporley GBX	State		Country	United Kingdom	Citizenship	UK
Post Office Address	7 Croft Close, Utkinton, Tarporley						
Post Office Address							
City	Tarporley	State		Zip	CW6 0XA	Country	United Kingdom

☐ Additional inventors are being named on the 1 supplemental Additional Inventor(s) sheet(s) PTO/SB/02A attached hereto

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DECLARATION

ADDITIONAL INVENTOR(S)
Supplemental Sheet
Page 1 of 1

2-00

Name of Additional Joint Inventor, if any:		☐ A petition has been filed for this unsigned inventor			
Given Name (first and middle [if any])		Family Name or Surname			
Andrew		Mount			
Inventor's Signature	[signature]			Date	25/4/01
Residence: City	Edinburgh GBX	State	Country: United Kingdom	Citizenship	UK
Post Office Address	18 Cambee End, Libberton,				
Post Office Address					
City	Edinburgh	State	Zip: EH16 6GJ	Country	United Kingdom

Name of Additional Joint Inventor, if any:		☐ A petition has been filed for this unsigned inventor			
Given Name (first and middle [if any])		Family Name or Surname			
Inventor's Signature				Date	
Residence: City		State	Country	Citizenship	
Post Office Address					
Post Office Address					
City		State	Zip	Country	

Name of Additional Joint Inventor, if any:		☐ A petition has been filed for this unsigned inventor			
Given Name (first and middle [if any])		Family Name or Surname			
Inventor's Signature				Date	
Residence: City		State	Country	Citizenship	
Post Office Address					
Post Office Address					
City		State	Zip	Country	